THORP

AGR Interim Storage Programme

Project Assessment Report ONR-SDFW-PAR-18-022
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EXECUTIVE SUMMARY

Modification of Existing Plant: THORP Receipt and Storage Pond Interim Fuel Storage

Permission Requested
In accordance with its arrangements under Licence Condition (LC) 22(1), "Modification or experiment on existing plant", of Schedule 2 of site licence 103, Sellafield Limited (SL), the licensee, has requested (Ref 1) the Office for Nuclear Regulation's (ONR) "agreement" to commence interim storage of AGR fuel in the Thermal Oxide Reprocessing Plant (THORP) Receipt and Storage pond, in accordance with a Category B Plant Modification Proposal (PMP).

Background
The THORP facility reprocesses spent uranium oxide fuel, extracting plutonium and uranium with resulting waste products. It is currently nearing the end of its operational life and scheduled to transition from commercial operations into Post Operational Clean Out (POCO) after the final fuel shearing operations in November 2018.

Post reprocessing, the majority of the THORP facility will transition into POCO and decommissioning, however some areas will continue to operate to support ongoing activities within THORP and other facilities elsewhere on site. In addition to this, SL is contractually committed to the receipt of spent Advanced Gas-cooled Reactor (AGR) fuel from Électricité de France Energy Nuclear Generation Ltd (EdF) which would have previously been reprocessed but from December 2018 will be interim stored until final disposal.

Under the NDA strategy for oxide fuels, up to 5500tU of AGR fuels and of the order of 100tU of legacy oxide fuels (that will be permissioned separately to this PAR and LI) are to be stored on the Sellafield Site until an export route to a Geological Disposal Facility (GDF) is available (currently expected 2085). In 2003, SL along with key stakeholders undertook a series of studies to identify potential solutions for interim storage of fuel and concluded that wet storage in the THORP receipt and storage pond (TR&S) was the optimum solution. ONR is content that this option is reasonable, meets UK strategic needs and that fuel will remain in an acceptable condition for final disposal.

SL is proposing to convert the existing TR&S pond from its current role as short term buffer storage prior to reprocessing, into an interim fuel storage facility prior to disposal in a future GDF. The physical modifications to facility to achieve this are relatively minor, with a new dosing system being installed increase pH from 9 to 11.4, and new storage rack to increase the storage capacity of the pond with the remainder of the pond equipment unchanged. SL states that in order to store fuel beyond the 1.7MW heat loading, additional cooling capacity will be required in the pond and that this would form part of a future submission to ONR in around 2023. Another safety case is expected in 2020 to justify the interim storage of Zirconium clad fuels.

Assessment and inspection work carried out by ONR in consideration of this request
ONR carried out a programme of work utilising specialist inspectors in Fault Studies, Chemical Engineering, Civil Engineering, Mechanical Engineering, Criticality, Structural Integrity, and Chemistry to assess SL's proposal and supporting safety case. In these activities we have:

- Performed assessments of SL's suite of safety case documents supporting the proposal.
- Reviewed a number of the reports produced by SL's Independent Nuclear Safety Assessment (INSA) team and Internal Regulators.
- Held meetings and discussions to feed back our assessment findings and allow SL to present new and/or revised evidence and proposals.

- Undertaken an inspection of the licensee's arrangements for managing and storing the life time quality records of the fuel to be interim stored.
- Undertaken a readiness review to gain confidence in the preparations for implementation.

Matters arising from ONR's work

The focus of ONR's assessment for this permission has been on modifications necessary to implement the 1.7 MW fuel heat limit storage case and assessing the licensee's claims, arguments and evidence demonstrating that the safety systems, both engineered and administrative, operate as claimed in the safety case. During the assessment process ONR specialist inspectors engaged with the licensee to resolve a number of minor clarifications and apparent shortfalls. Following this, ONR had no remaining concerns that would prevent agreeing to the licensee's proposal and all specialist inspectors support the release of the LI to enable SL to commence storage of AGR fuel in TR&S up to a heat limit of 1.7MW.

During the assessment, inspectors identified a number of areas where the licensee needs to further develop its safety case to substantiate safe storage of an increased fuel heat limit above 1.7MW. These have been captured as actions in a Regulatory Issue (RI6733) and shared with the Licensee as conditions of future ONR permissions.

Conclusions

I have reviewed the licensee's safety case and arrangements for interim storage of AGR fuels in TR&S and judge that these are adequate and demonstrate that risks have been reduced to as low as reasonably practicable. This judgement is supported by ONR nuclear safety specialist inspectors who have assessed specific areas of the safety case.

I carried out a readiness inspection of the plant, people and processes associated with implementing the ASTOP safety case and I am satisfied that the licensee has adequate arrangements to commence interim storage of AGR fuels.

I have reviewed the licensee's failed fuel management case and I am content that this covers the full range of operations and reasonably foreseeable scenarios, and that SL has adequate contingency built into its arrangements should through life monitoring identify a problem. These views are supported by the Structural Integrity and Chemistry specialist inspectors who also assessed these aspects of the licensee's safety case.

On the basis of ONR's assessment and inspections, I am content that the licensee's claims, arguments, and evidence presented in its safety case adequately demonstrate that the licensee has developed an adequate safety case to justify the interim storage of AGR fuel in the TR&S pond up to 1.7MW.

I consulted the Environment Agency who have raised no objections to ONR agreeing to the licensee's proposal. I recommend that ONR issues LI516 to release the regulatory hold point to allow SL to interim store AGR fuel in TR&S up to a heat loading of 1.7MW.

Recommendations

The project assessment report recommends that ONR issues LI516 to allow SL to start interim storage of AGR fuels in TR&S up to a heat loading of 1.7MW.

LIST OF ABBREVIATIONS

AGR	Advanced Gas Cooled Reactor
AGRSP	Advanced Gas Cooled Reactor Storage Pond
AHF	Active Handling Facility
ALARP	As low as reasonably practicable
ASTOP	AGR Storage Programme
c	AGR Fuel Can
C&I	Control and Instrumentation
CNS	Civil Nuclear Security (ONR)
CSC	Criticality Safety Criterion
EA	Environment Agency
EDF	Électricité de France Energy Nuclear Generation Ltd
EIMT	Examination, Inspection, Maintenance, and Testing.
FHP	Fuel Handling Plant
GDF	Geological Disposal Facility
HAZAN	Hazard Analysis
HOW2	(Office for Nuclear Regulation) Business Management System
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IBC	Intermediate Bulk Container
INSA	Independent Nuclear Safety Assessment
LC	Licence Condition
LI	Licence Instrument
LTQR	Lifetime Quality Records
LWR	Light Water Reactor
MOX	Mixed Oxide (Fuel)
MSC	Management Safety Committee
MW	Mega Watt
NDA	Nuclear Decommissioning Authority
NNL	National Nuclear Laboratory
NSC	Nuclear Safety Committee
ONR	Office for Nuclear Regulation
OR	Operating Rule
OSP	Overarching Safety Proposal
PAR	Project Assessment Report (ONR)
pH	Potential of Hydrogen
PMP	Plant Modification Proposal
POCO	Post Operational Clean Out

RGP	Relevant Good Practice
RI	Regulatory Issue
RWM	Radioactive Waste Management
SAMS	Severe Accident Management Strategy
SAP	Safety Assessment Principle(s)
SCIP	Safety Case Implementation Plan
SI	Structural Integrity
SIXEP	Site Ion Exchange Effluent Plant
SL	Sellafield Limited
TAG	Technical Assessment Guide (ONR)
TCA	Temporary Commissioning Aids
THORP	THermal Oxide Reprocessing Plant
TR&S	THORP Receipt and Storage
tU	tonnes Uranium

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1 PERMISSION REQUESTED

1. In accordance with its arrangements under Licence Condition (LC) 22(1), "Modification or experiment on existing plant", of Schedule 2 of site licence 103, Sellafield Limited (SL), the licensee, has requested (Ref 1) the Office for Nuclear Regulation's (ONR) "agreement" to commence interim storage of AGR fuel in the Thermal Oxide Reprocessing Plant (THORP) Receipt and Storage pond up to a heat loading of 1.7MW, in accordance with a Category B Plant Modification Proposal (PMP). The following safety case documentation was submitted for consideration by ONR:

- OFSG/BXXX/0844 – Implementation of the TR&S interim Storage Case (up to 1.7MW fuel heat load)(Ref 2)
- OSP/BXXX/ASTOP – Overarching Strategy Paper for implementation of the TR&S Interim Storage safety case(Ref 3)
- SCIP/PMP/OFSG/BXXX/0844 – Safety Case Implementation Plan for TR&S Interim Storage Safety Case (Ref 4)
- RP/BXXXCOSR/SAFE/00145 - Safety Case Summary for Interim Storage of Oxide Fuels in THORP Receipt and Storage.(Ref 5)
- CULT 18251 - Chemical Challenges to Primary and Secondary Containment during ASTOP (Ref 6)
- CULT 18243 - Safety Assessment for Loss of Pondwater Cooling (Ref 7)
- CULT 18432 - Safety Assessment of ASTOP Fuel Repacking Operations in THORP Feed Pond (Ref 8)
- CULT 17740 - Criticality Safety Assessment of AGR Interim Storage within the Thorp Receipt and Storage Facility (Including Associated Operations in Thorp Feed Pond) (Ref 9)
- CULT 18512 - External Hazards Assessment in Support of ASTOP (Ref 10)
- CULT 18481 -Severe Accident Analysis and RESEP Review for ASTOP (Ref 11)
- RP/TH-BXXX/PROJ/00188 - Design Assessment/Justification Report (Ref 12)
- OFSG/ASTOP/ALARP - Assessment of shortfall/recommendations against ASTOP ALARP considerations (Ref 13)
- INSA certificate (Ref 14)
- MSC minutes for meetings (Ref 15)
- NSC minutes for meeting (Ref 16)

2. No existing licence instruments have been identified for amendment or revocation as a result of this agreement.

3. This Project Assessment Report (PAR) has been written to present the basis for the permissioning decision made by ONR. The rationale for regulating this permission through a PAR and Licence Instrument (LI) is captured in the Sellafield Sub-Division Objective 4 task sheet (Ref 17) and decision record (Ref 18).

4. This report has been prepared in accordance with the requirements of the ONR business management system HOW2 (Ref 19).

2 BACKGROUND

2.1 FACILITY INFORMATION

5. The THORP facility reprocesses spent uranium oxide fuel, extracting plutonium and uranium with resulting waste products. It is currently moving towards the end of its operational life and scheduled to transition from commercial operations into Post Operational Clean Out (POCO) after the final fuel shearing operations in November 2018.

6. Post reprocessing, the majority of the THORP facility will transition into POCO and decommissioning however some areas will continue to operate to support ongoing activities within THORP and other facilities elsewhere on site. In addition to this, SL is contractually committed to the receipt of spent Advanced Gas-cooled Reactor (AGR) fuel from Électricité de France Energy Nuclear Generation Ltd (EdF) which would have previously been reprocessed but from December 2018 will be interim stored until final disposal.

7. Under the NDA strategy for oxide fuels, up to 5500tU of AGR fuels and of the order of 100tU of legacy oxide fuels (that will be permissioned separately to this PAR and LI) are to be stored on the Sellafield Site; lasting until an export route to a Geological Disposal Facility (GDF) is available (currently expected 2085). In 2003 SL, along with other key stakeholders, undertook a series of studies to identify potential solutions for interim storage of fuel at site. These studies concluded that wet storage in the THORP receipt and storage pond (TR&S) was the best solution (Ref 5). These were reviewed by ONR and EA inspectors as they were produced to ensure regulatory requirements and expectations had been adequately considered and incorporated. I have conducted a further assessment as part of this permission (see section 4.8).

8. TR&S was constructed between 1983 and 1988 and commenced active operations in 1988. The facility comprises a receipt building and two storage ponds. Its role on the Sellafield site since commissioning has been to provide buffer storage of Light Water Reactors (LWR), research reactor, and AGR fuels prior to reprocessing in THORP. TR&S was originally a demineralised water pond but has been dosed to pH 9 since 2015.

2.2 LICENSEE'S PROPOSAL

9. SL is proposing to convert the existing TR&S pond from its current role as short term buffer storage prior to reprocessing into an interim storage facility prior to disposal in a future GDF. The physical modifications to facility to achieve this are relatively minor, with a new dosing system being installed to increase the pond water pH from 9 to 11.4, and new storage rack to increase the storage capacity of the pond with the remainder of the pond equipment unchanged.

10. SL states that the current cooling systems installed in the pond are suitable to support interim storage of AGR fuel up to a heat loading of 1.7MW, which equates to around 600te of fuel or approximately 5-6 years of AGR fuel receipts from EDF. The 1.7MW limit is being implemented through a new operating rule (required Operating Instruction - rOI) and represents a significant reduction from the current safety case limit of 4MW. This reduction is due to the fact the fuel will no longer be reprocessed hence must be able to be maintained in a condition suitable for final disposal.

11. The 600te of fuel that can be stored is significantly less than the 5500te fuel that needs to be stored in total. In order to enable increasing the 1.7MW limit, the current cooling systems must be improved. SL is currently developing the design and safety case for the new cooling systems and to enable it to store fuel beyond the 1.7MW limit. This work is scheduled to be completed in around 2023 and will be implemented through a future PMP subject to regulatory assessment and permission prior to implementation. Another safety case is also expected in 2020 to justify the interim storage of Zirconium clad fuels, including mixed oxide fuel (MOX) and other legacy oxide fuels. The licensee's strategy for managing and implementing the modifications necessary to implement these changes is described in the Overarching Safety Proposal (Ref 3) which has been assessed by ONR (see section 4 for details).

12. The key risks associated with this safety case relate to maintaining the integrity of the fuel, the equipment needed to safely manage the fuel and facility over a ~70 year storage period. SL states that the pond is generally in good condition, however

acknowledges that owing to the long term operational requirements some aspects will require replacement and/or enhanced maintenance arrangements to ensure the key equipment continues to operate as required. These aspects have been assessed by ONR Civil Engineering and Mechanical Engineering specialist inspectors. The key faults around the integrity of the fuel are associated with failure of the fuel cladding releasing activity into the pond water and onwards to the environment. The main protective measures against this are the pH dosing which prevents corrosion, and the pond water cooling systems which maintain the temperature to a level where corrosion is minimised. These aspects have been assessed by ONR specialists in Chemistry, Structural Integrity, and Chemical Engineering. ONR's key assessment findings are discussed in Section 4.

13. In support of this activity SL has submitted the safety case documentation cited in Section 1 of this report to ONR.

14. The Plant Modification Proposal (PMP) (Ref 2) identifies this as a category 'B' modification within SL's arrangements as it is a significant modification to the current strategy for managing spent nuclear fuel with the potential for onsite radiological consequences if inadequately conceived or implemented. I have reviewed the PMP and I am content it has been appropriately categorised. It is effectively reducing the current safety case limits (heat loading and fuel storage capacity of the pond), meaning the extant safety case and severe accident analysis adequately bounds new operations including withstand against extreme events. The PMP presents the extent of the works necessary to modify the existing plant and safety case to enable to the interim storage of spent AGR fuel up to a heat loading of 1.7MW. The PMP also introduces new limits and conditions defining the maximum heat loading for fuel stored within the pond and the conditions for acceptance of the fuel to be interim stored i.e. minimum cooling time and maximum burn-up limits.

15. This permission is to allow SL to interim store AGR fuel in TR&S up to a heat loading of 1.7MW (approx. 600te of fuel). It is the first in a series of permissions required to fully implement the interim storage of fuel in TR&S up to 9MW and the full 5500te of fuel. The Overarching Strategy Paper (Ref 3) describes the strategy for the implementation of the overall interim storage case and identifies the future hold points (storage of non-AGR fuels, introduction of 63c racks, enhanced cooling to enable storage above 1.7MW, and enhanced NaOH storage and dosing equipment) necessary to fully implement the interim storage capability. ONR will continue to monitor SL's progress in producing these new safety cases and will assess and permission them as appropriate.

16. The Safety Case Implementation Plan (SCIP) (Ref 4) details the actions SL will take to implement the ASTOP interim storage safety case once it receives the LI from ONR so it can commence storage of AGR fuels up to a heat loading of 1.7MW.

17. The Safety Case Summary Document (Ref 5) summarises the safety case for the AGR interim storage, identifying the aspects of the existing THORP safety case that are being retained, aspects that are being modified, and aspects that are new. The detailed safety assessment for each aspect of the case is captured in the HAZANs (Refs 6-11)

18. The design assessment and justification report (Ref 12) substantiates the safety functions of the structures, systems and components required to enable interim storage of AGR Fuel in TR&S until the GDF is available. The ALARP report reviews the shortfalls identified in SL's safety case development phase and details how these have been addressed, or details how they will be addressed as part of the future PMPs detailed in the OSP.

19. I note that SL has subjected the suite of safety case documents to a prescribed checking and approval process in accordance with its arrangements made under the licence conditions. I have taken due note of comments from its Independent Nuclear Safety Assessment (INSA) (Ref 14) which identified minor issues in the safety case which have been adequately addressed. I am satisfied that SL's due process has been followed and that the safety case documentation was approved at the relevant Management Safety Committees (MSC) (Ref 15) and the Nuclear Safety Committee (NSC) (Ref 16).

3 ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST

20. The Licensee's current safety case allows it to store used fuels up to a heat loading of 4MW prior to reprocessing. The licensee's request for permission to convert the TR&S into an interim storage facility significantly reduces the heat loading to 1.7MW which in turn reduces the total amount of fuel that can be stored in the pond. These reductions are necessary as there needs to be a higher degree of confidence in the fuel integrity until the GDF is available (currently estimated for 2085) rather than a few years prior to reprocessing. As this permission reduces the amount of fuel that can be stored, the extant arrangements for external hazards and severe accident analysis bound future operations. These aspects have been reviewed by ONR specialist inspectors in Fault Studies and Civil Engineering.

21. In accordance with ONR's regulatory strategy and scope defined in the Sellafield Division Objective 4 Task Sheet (Ref 17) related to this project, ONR carried out a programme of work utilising specialist inspectors in Fault Studies, Structural Integrity, Chemical Engineering, Mechanical Engineering, Civil Engineering and Chemistry to assess SL's proposal and supporting safety case. In these activities we have:

- Performed assessments of SL's suite of safety case documents supporting the modification
- Reviewed a number of the reports produced by SL's Independent Nuclear Safety Assessment (INSA) team and Internal Regulators (Nuclear Independent Oversight)
- Held meetings and discussions to feed back our assessment findings and allow SL to present new and/or revised evidence and proposals
- Undertaken an inspection of the quality records management
- Undertaken a readiness inspection to confirm safety case implementation arrangements.

22. SL undertook a Human Factors review (Ref 34) as part of the development of this safety case which concluded that all key claims on operators were adequately substantiated in the existing safety case, and that there are no new safety claims made on operators. I have reviewed the safety case and am satisfied that all key safety claims are bounded by the existing safety case and unaffected by this modification.

23. In line with ONR's permissioning process, further supporting documentation was requested by ONR and is referred to where appropriate within this PAR.

3.1 CONSULTATION WITH OTHER AGENCIES AND DEPARTMENTS

24. I have consulted the Environment Agency (EA), which confirmed that it has no objection to the issuing of a licence instrument in this matter (Ref 20).

25. The nature of this proposal does not relate to the transport of nuclear material, or significantly impact on the security or safeguarding arrangements for the spent fuel, therefore I have not consulted with ONR's inspectors within these areas.

4 MATTERS ARISING FROM ONR'S WORK

26. Since the process for receiving, de-canning, and transporting the fuel on site remains unchanged from the current processes, which have been in operation for approximately 30 years and subject to regulatory oversight, the focus of ONR's assessment has been on the aspects of the plant and processes that are being modified. I have discussed these aspects with the Site Inspectors for THORP and FHP who have confirmed that they are content with SL's arrangements in these areas. This report covers ONR's assessment of the claims, arguments and evidence presented by the licensee to demonstrate that it can safely store fuel in the facility for 70+ years. The findings of each specialist inspector are summarised below.

4.1 FAULT STUDIES ASSESSMENT

27. The fault studies specialist inspector's assessment (Ref 22) reviewed the licensee's process for the developing the ASTOP safety case. As part of this review the inspector considered the following aspects:

- Safety Case Structure and Visibility
- Hazard Identification
- Inventory, Source Terms, Modelling and normal Control Limits

28. The inspector compared the licensee's evidence against relevant regulatory expectations detailed in the ONR SAPs and concluded that the licensee has an adequate process for identifying faults and ensuring that the overall safety case is appropriately visible and usable by the operators. Following this review the inspector identified that the most significant faults in the ASTOP safety case were associated with the Loss of Pond Water Cooling and from Fuel Repacking Operations. For each of these faults the inspector assessed the licensees safety case in the following areas in detail:

- Radiological Consequences
- Limits and Conditions (Operating Rules)
- Designated Safety Measures

29. The fault studies specialist inspector has reviewed the licensee's radiological consequence assessment and is content that these have been calculated on a conservative basis and that appropriate safety measures have been developed to prevent and mitigate these consequences.

30. The inspector notes that SL has implemented a suite of safety limits and conditions (defined as Operating Rules -OR and required Operating Instructions - rOI's under SL's arrangements) which define the safe operational envelope of the plant. The inspector is content that these comply with the requirements of LC23 and the regulatory expectations in TAG 35. The main OR limits the temperature of the pond water to 50˚C which ensures the pond structure and fuel integrity are maintained at safe levels with sufficient safety margin. These aspects have also been reviewed in detail by the structural integrity and civil engineering specialist inspectors who are satisfied they are adequate. In addition, a number of rOI's define the conditions (Maximum Burn Up, and minimum Cooling time) necessary for safe interim storage in TR&S. The other key rOI limits the maximum heat loading in the pond to 1.7MW which represents the limits of the existing pond cooling systems, which have been assessed by the chemical engineering specialist who is content these are adequate. Overall the fault studies specialist is satisfied that SL has identified and developed appropriate limits and conditions necessary to enable safe interim storage of fuel in TR&S.

31. The fault studies specialist is content that SL's proposals will adequately control the hazards and that the associated risks have been reduced ALARP. The inspector

recommends that ONR releases the hold point to allow SL to proceed with the first stage of the ASTOP i.e. to enable interim storage AGR fuel up to 1.7MW.

4.2 CHEMICAL ENGINEERING ASSESSMENT

32. The chemical engineering specialist undertook a review of the safety case and focussed their assessment (Ref 23) on the fault sequences associated with loss of pond water cooling and on the suitability of the licensee's strategy and equipment to implement pH 11.4 dosing within the pond. These represent those aspects of the safety case with the highest potential consequences with significant claims made on chemical engineering.

33. For the loss of pond water cooling, the assessment has focussed on two areas the operating rule limiting the bulk pond water temperature to 50˚C and the overall pond heat load limit of 1.7MW. The inspector notes that the 50˚C bulk pond water limit is derived from a maximum allowable temperature of the fuel of 70 ˚C, which has been assessed by the structural integrity specialist (see section 4.6), and is based on a heat transfer for model for the 20c skip and the 63c rack which will be used to store fuel in TR&S. The inspector reviewed the heat transfer models generated by National Nuclear Laboratory (NNL) that predict the temperatures in the 20c skip and 63c rack and is content that they are adequate and based on sound engineering principles as detailed in the ONR SAPs and IAEA guidance on spent fuel storage. The inspector notes that the 63c rack model has not been fully validated by on-plant data as the racks have not been constructed and installed.

34. However, as the 20c skip and 63c rack have similar storage channels, with the 63c rack essentially being three 20c skips stacked on top of each other, the validation done on a triple stacked 20c skip provides assurance that the model is also valid for 63c racks. The inspector reviewed the licensee's arrangements to validate the 63c rack model, which involves using thermocouples to monitor temperatures within the channels, and is content these are adequate. If during the plant validation the 63c rack does not perform as expected then the fuel can continue to be stored in 20c skips whilst the design of the 63c rack is modified or a new storage rack is developed. Any fuel stored in a 63c rack can also be transferred back into a 20c skip if the rack does not perform as expected. The inspector recommends (Chemical Engineering Recommendation 1):

- The ONR chemical engineering specialist to track the completion of the validation of the 63 can rack thermal model, and the associated confirmation that the 50 °C operating rule remains adequately underpinned with a 63c rack.

35. The only way to fully validate the model is through operational experience. Since it will take a few years worth of data to fully validate the rack this will be assessed as part of the future permissioning to increase the heat loading in the pond. This recommendation has been captured in a L3 Regulatory Issue (RI6733) along with the other recommendations raised by inspectors in this report for work required to be completed and assessed as part of future regulatory permission to allow SL to increase the heat loading in the pond to 9MW. RI6733 has been shared with the licensee through a regulatory letter and licensee progress in addressing this will be monitored by the inspector responsible for TR&S going forwards.

36. Regarding the selection of a 1.7MW heat load limit, the specialist inspector reviewed the modelling undertaken by the licensee and is content that this is based on sound calculations and reasonable assumptions. The inspector notes that the model has been validated against real data for TR&S and the Maine Yankee Pond in the USA. On this basis is content that the limit has been adequately justified by the licensee.

37. The inspector conducted a review of the safety measures in place and notes that there are three independent and diverse systems (Pond purge, TR&S Ventilation, and pond cooling systems) that maintain the pond temperature within the safety case limits. The inspector also notes that if the pond is operating at its maximum normally permissible temperature (30˚C) upon loss of all three systems that it would take more than two weeks for the pond to reach the 50 ˚C safety case limit. The inspector judges that for all initiating events (e.g. loss of power owing to external events) this gives the licensee adequate time to restore the ventilation, pond purge, or cooling systems which can maintain the plant within the safety case limits. This view is further supported by the fault studies specialist.

38. The inspector also assessed the licensee's strategy for pH dosing the pond. This consists of a two phase approach, with the licensee initially installing a temporary dosing system to enable timely dosing of the TR&S pond in line with the safety case requirements. SL's original intent was to install a permanent system and it identified the equipment necessary to do this. However, owing to the effect of carbonation identified during the pH9 dosing campaign, this means that significantly more caustic is required than originally anticipated rendering the original equipment unsuitable (Ref 35). The pH dosing is a key safety measure of the new safety case. SL identified that there was insufficient time to design and install a permanently engineered dosing system as part of this safety case, hence developed a short term solution utilising the intermediate bulk containers (IBC) that the caustic is delivered in. The specialist inspector has reviewed the licensee's option study report (Ref 21) and accepts SL's arguments that it does not have enough time to design and install a permanent fully engineered pH dosing system to coincide with the conclusion of THORP reprocessing operations. The inspector agrees that a two phase approach is necessary as if the pH in the pond is not increased it will significantly undermine the interim storage safety case, and any delays would cause significant operational and safety challenges at other facilities on site and may potentially require AGR stations to stop generation.

39. The inspector has assessed the phase 1 dosing system design, which is based on the system installed and currently in use at AGR Storage Pond (AGRSP), and is content that this is suitable to support the commencement of interim storage until the fully engineered phase 2 system is installed. The inspector makes the following recommendation:

- The site and project Inspectors should assure themselves that the licensee has appropriate arrangements in place to develop and implement a permanent engineered solution for pH dosing.

I have reviewed the licensee's plans for implementing this (Ref 3) and note that work on the design of the phase 2 system is currently in progress and scheduled to be installed by 2023. The chemical engineering inspector has reviewed this plan and is satisfied that the phase 1 system is suitable for use over this timeframe. The design and implementation of the phase 2 dosing system will be assessed as part of the 9MW safety case and has been included in RI6733 which will be tracked to completion by the ONR inspector responsible for TR&S.

40. Overall the Chemical Engineering specialist is satisfied with the claims, arguments, and evidence in the licensee's safety case and supports the release of the regulatory hold point to enable SL to interim storage AGR fuel up to a heat a loading of 1.7MW.

4.3 CIVIL ENGINEERING ASSESSMENT

41. The civil engineering specialist inspector reviewed the key civil engineering claims made on the pond to support interim storage (Ref 24). As such their assessment focussed on the following aspects of the licensee's safety case:

- The demands placed on the existing civil assets
- Potential changes in leakage rates due to changing operating conditions
- Changes in the internal environment within the pond superstructure
- Measures to ensure ongoing performance of civil safety functions throughout the storage period taking into account future changes external hazards

42. The inspector has reviewed the future demands (gravity loading, pH increase, seismic withstand, and impact of climate change) on the pond structure against the original design of the facility. The inspector is satisfied that the pond structure is suitable to meet these future demands, including contingency to allow for the foreseeable changes to external hazards regarding climate change, seismic events, changes in the thermal loading of the pond, and water bar levels. Overall the inspector is satisfied that the design of the pond meets the relevant good practice detailed in the SAPs.

43. The inspector notes that increase pond water temperature may result in changes in the current pond leakage rates. At present there some minor leaks in the pond, which is typical of concrete structures of this nature, and that these are captured in an engineered sump and returned to the main pond. The leakage rates are monitored through operational rounds and trended to provide assurance that they are not changing. The inspector has reviewed SL's operational experience and modelling that shows the leakage rates reduce as pond water temperature increases and is content that the model is based on sound assumptions and science. The inspector judges that the increase in pond temperature as result of this permission should further reduce this leakage and is content that the licensee's arrangements for monitoring leaking rates in the pond meet the regulatory expectations detailed in the SAPs.

44. The inspector has reviewed the impact of the increasing heat loading of the pond on the internal environment and is content that the existing ventilation systems are adequate to handle the projected 1.7MW heat loadings. The inspector notes that licensee's existing EIMT arrangements are adequate but advises that a more proactive regime is developed in advance of the future permission to increase the heat loading to 9MW; this has been captured and shared with SL via RI6733.

45. The inspector raises six recommendations, the first relates to future climate change and the potential impact this may have on the civil structure. The inspector recommends that this is reviewed as part of future permissions. I support this recommendation and have included it in RI6733. This and similar aspects will also be reviewed at least on a 10 yearly basis in accordance with the regulatory expectations under LC15 – Periodic Safety Review.

46. The civil engineering specialist inspector also makes recommendations related to the replacement and ongoing maintenance of the TR&S facility roof. The current TR&S roof is reaching the end of its design life and showing signs of fatigue with small leaks occurring during heavy rainfall. Flat roofs of this type slowly degrade through increasing leak rates, the pH dosing will provide effective protection of the pond water against these leaks in the short term (as demonstrated by operational experience at other pH dosed open ponds on site) until the TR&S roof is replaced. SL has plans to replace the TR&S facility roof in the next few years which are supported by the civil engineering inspector. As the roof forms the first barrier against chloride ingress it is a key aspect of the safety case for interim storage. I support the specialist inspector's recommendation that the roof should be renewed and have captured this in RI6733 with the expectation that the roof is replaced as soon as reasonably practicable and prior to the regulatory hold point to increase the heat loading to 9MW currently scheduled for 2023.

47. The TR&S facility will continue to be subject to regular ONR inspection until the risk from the facility reduces (i.e. the spent fuel is removed) to a level where this is no longer required.

48. Another recommendation refers to the need for SL to implement necessary improvements to the pond cooling systems to support increasing the fuel heat loading in the pond in the future. I have included this in RI6733 to ensure this is assessed by ONR as part of the future permissioning work.

49. As the facility will be in operation for a prolonged time period the specialist inspector recommends (recommendation 4) that ONR continues to monitor and inspect the licensee's LC28 arrangements for leakage at joints in the concrete structure. Whilst the licensee's current arrangements are judged to be adequate, the long time frame the facility is required to operate means that this needs to be kept under regulatory observation. Relevant EMIT-based recommendations will also be incorporated into the ONR inspection plans for the facility going forwards which cover all key safety systems on the facility as part of the SCIE inspection strategy and 5 yearly plan (Ref 33).

50. The final recommendation refers to the licensee's arrangements for the chemical analysis of the pond water to ensure that the pH levels are adequately controlled. This aspect has been assessed by the ONR chemistry specialist inspector who is content that the licensee has adequate arrangements in this area.

51. Overall the inspector is satisfied with the claims, arguments and evidence laid down in the licensee's safety case and supports release of the hold point to allow SL to interim store spent AGR fuel up to a heat load of 1.7MW.

4.4 MECHANICAL ENGINEERING ASSESSMENT

52. The mechanical engineering specialist inspector's assessment (Ref 25) has undertaken a review of the licensee's safety case to identify where key safety claims were made on mechanical equipment. The following aspects were identified as areas where significant safety claims are made on mechanical equipment which were assessed in detail:

- 63 Can Rack
- Lifting and Handling
- Asset Management
- Pond Cooling Equipment.

53. The inspector undertook a detailed assessment of the 63 can rack being which has developed for storage of AGR fuel in TR&S, included assessing the design, manufacture, and lid sealing arrangements. The inspector identified that the lid seal is only substantiated to last around 40 years and that whilst this is shorter than the time until the GDF is scheduled to be available (~2085) the inspector judges that SL has adequate arrangements in place to monitor the seal integrity and replace it if necessary. Whilst SL has not replaced a seal on the 63c rack, the process is not complex and similar activities have been undertaken elsewhere on site providing the necessary assurances it can be completed if required at TR&S. The seal can either be replaced with the fuel in situ or the fuel can be transferred to another 63c rack with a new seal whilst the seal on the original rack is replaced. Overall the inspector is content that the licensee's arrangements for the design, manufacture and operation of the 63c rack meet relevant regulatory expectations detailed in the SAPs.

54. In order to store all the AGR fuel within the pond it needs to be repacked from the current 20c skips into the new 63c racks. Since this is expected to require around 650 racks and a total of 5500te of fuel, this is likely to be a significant operation. The mechanical specialist inspector has reviewed this and is content that licensee has

identified the bounding cases and key faults (dropped rack, side impact, and toppled rack) and is satisfied that adequate safety measures are in place to prevent and mitigate these faults. These fault sequences were also assessed by the fault studies specialist inspector who supports the mechanical engineering specialist inspector's conclusions (see section 4.1).

55. The inspector notes that as the pond is required to operate for a prolonged time the key equipment (main pond crane and skip handler) needs to be maintained to ensure it continues to deliver its safety function. The inspector has reviewed the current equipment and is satisfied that there are no life-limiting features installed that cannot be repaired or replaced as necessary. Whilst obsolescence of some of the control systems and other equipment will occur during the interim storage period the inspector is content that this can be managed through SL's existing operational arrangements. The inspector has reviewed the licensee's asset management and LC28 arrangements and is content that these meet regulatory expectations detailed in the ONR SAPs and Technical Assessment Guides. ONR will continue to inspect these arrangements throughout the lifetime of the pond through planned LC28 compliance, systems based inspections, and other routine regulatory business.

56. The inspector is also of the opinion that there is adequate capacity and redundancy in the cooling water system and accepts SL's case of the proposed safety case limit of 1.7MW.

57. Overall, the inspector is satisfied with the claims, arguments and evidence within the licensee's safety case and supports ONR granting permission for SL to commence interim storage of AGR fuel in TR&S up to a heat loading of 1.7MW.

4.5 CRITICALITY ASSESSMENT

58. The criticality specialist inspector's assessment (Ref 26) reviewed the licensee's criticality safety case for interim storage of AGR fuel in TR&S. Their assessment focussed on the follow aspects:

- Fissile Materials Present
- Criticality Safety Criterion (CSC) Case for Normal and Fault Conditions
- Operating Rules
- Criticality Warning System Omission.

59. The criticality inspector is satisfied that SL has identified the bounding case for AGR fuel enrichment levels that will be stored within the TR&S and that the value claimed in the safety case is appropriate. The inspector assessed the licensee's CSC case and is content that reactivity values used are justified. For normal conditions, the inspector is content that there is a large margin of safety against criticality. In addition, the inspector is satisfied that the licensee has identified all reasonably foreseeable faults that may lead to criticality and has adequate safety measures in place to prevent them occurring. The inspector notes that the operating rules and operating instructions associated with criticality control are clear. These operations have been assessed by SL HF specialists (Ref 34) who are content they are equivalent to the existing arrangements for the 20c skip. Therefore the criticality specialist inspector is satisfied that SL's arrangements for this meet the regulatory expectations detailed in TAG35.

60. The inspector is also content with the licensee's case not to install a criticality warning system, as the pond water provides significant shielding meaning any criticality would result in low dose uptake by the operators and that any system installed would be unlikely to detect a criticality owing to the shielding provided by the pond water.

61. The Criticality Specialist inspector is content that the claims, arguments and evidence presented by SL in its criticality safety case demonstrates that risks have been

reduced ALARP. The inspector recommends that ONR issues the LI to allow the interim storage of AGR fuel up to 1.7MW in TR&S.

4.6 STRUCTURAL INTEGRITY ASSESSMENT

62. The structural integrity (SI) specialist's assessment (Ref 27) focussed on the integrity of the AGR fuel clad as this represents the primary containment boundary in the licensee's safety case. The inspector reviewed the potential corrosion mechanisms and agrees with the licensee that radiation induced segregation within the cladding means that intergranular attack or stress corrosion cracking is likely to be the main mechanisms that could lead to fuel failure.

63. The inspector assessed the licensee's main safety measures to control the pH and temperature of the pond water to guard against the initiators for these corrosion mechanisms. The inspector is satisfied that if the conditions of the pond are controlled within the normal conditions (i.e. pH11.4 and < 30°C) there is adequate protection for the fuel against corrosion leading to cladding failure. Under fault scenarios the conditions within the pond could deviate from this region which would increase the probability of fuel failure. There are two broad faults that could lead to this, loss of cooling and chloride ingress.

64. In loss of cooling faults the pond temperature could increase beyond these levels to around 50 °C with the resultant fuel clad temperature at 62 °C. The licensee's safety case states the high temperature conditions could last for a maximum of around three weeks. The inspector notes that in these conditions some crack promulgation cannot be deterministically excluded but as the rate is slow they agree with the licensee's claims that this will not result in fuel failure and that the licensee's safety case is adequate in this respect. In the event that there are fuel failures this would be identified through routine sampling of the pond water detecting Cs-137. Upon detection, SL will undertake further sampling to identify the failed fuel elements and monitor, isolate, or transfer the fuel to another facility (AGRSP or AHF) for storage or treatment as appropriate. The SI inspector has undertaken a review of these measures and is content they are adequate. These aspects are assessed in more detail in sections 4.7 and 4.8.

65. The inspector reviewed SL's claims on corrosion at higher temperature and the evidence (modelling, 30 years of operational experience, and container trials) that underpin them, and is content that the claims are justified for the short to medium term (up to around 30 years). The structural Integrity specialist notes that there are some shortfalls around the interim storage case to do with uncertainties around active damage mechanisms (corrosion) at high temperatures and recommends that SL takes further work to address these uncertainties to support storage until the GDF is available. As the heat load of the pond is limited to 1.7MW even under fault conditions the high temperatures will only exist for a short time period (maximum of 20 days) (See Section 4.1 & 4.2) for which the SI specialist inspector is content the fuel has been adequately substantiated. The SI specialist inspector has reviewed the licensee's plans to address stored fuel behaviour at high temperature and is content they are adequate. ONR will review progress as part of the future permission to increase the heat loading in the pond to 9MW currently scheduled for 2023. This matter was also noted by the chemistry inspector who reached a similar conclusion (See section 4.7). I have reviewed this recommendation and agree with the SI specialist inspector. I have shared the recommendations with the licensee via RI6733 with the expectation that the uncertainties are addressed as part of the safety case to increase the heat loading to 9MW currently scheduled for 2023.

66. In a loss of chemistry control fault, the main risk occurs if there is chloride ingress. The inspector concludes that since TR&S is a closed pond the risk of chloride ingress is relatively low. The SI inspector has assessed the licensee's claims around the efficacy

of the pH shield in other open ponds and agrees with SL that high pH will provide effective protection against chloride induced failures. The licensee's safety case to control pH dosing has been assessed by the Chemistry (see section 4.7) and Chemical Engineering Specialists (Section 4.2) who are content it is adequate.

67. The SI specialist has reviewed SL's arrangements for inspection of the fuel throughout the storage period using endoscopy and corrosion coupons and is satisfied that these are reasonable. If these indicate that there are areas requiring closer inspection the fuel can be transferred to AHF for more detailed examination and analysis. The inspector is satisfied with SL's proposals on treating failed fuels (see section 4.8 for more details) and is content that any failures would be detected via Cs-137 in the pond water through the extant pond sampling arrangements that have been proven successful over many years of operation. However, there are some shortfalls in the licensee's understanding of the efficacy of the pH dosing over prolonged time. The inspector is satisfied that SL is taking appropriate action to address this and recommends that the project inspector ensures that the licensee implements adequate EIMT arrangements to demonstrate primary containment boundary claim on the intact, irradiated AGR fuel cladding throughout the interim storage period under controlled thermo-chemical environment.

68. I have reviewed the licensee's EIMT arrangements as part of the readiness review (see section 4.8) and I am content its arrangements are adequate to support the interim storage of AGR fuel in TR&S up to a heat loading of 1.7MW. I have noted that further development work is necessary to provide assurance of the integrity over the whole storage period. This is only feasible through operational experience. This will be reviewed as part of the next permission to store fuel beyond the 1.7MW limit in this permission which is scheduled for around 2022/23.

69. The specialist inspector concludes that risks from all the relevant fuel damage mechanisms associated with storage at SL/TR&S pond, potentially challenging the primary pressure boundary claim on the intact irradiated AGR fuel cladding have been reduced to ALARP. The inspector recommends that ONR issues LI516 to allow the interim storage AGR fuel in TR&S up to a heat loading of 1.7MW.

4.7 CHEMISTRY ASSESSEMENT

70. The chemistry specialist inspectors assessment (Ref 28) has focussed on the following aspects where there are safety claims made on the chemistry conditions in the pond:

- Justification of the pH11.4 Operating Conditions
- Modelling of Caustic Dosing Requirement to Maintain pH11.4 in TR&S
- Pond Water Condition Monitoring Plant to Support interim storage in TR&S.

71. The chemistry specialist has assessed the selected operating conditions for the pond and is content these are reasonable based on the modelling, research, and operational experience of wet storage of fuel on site. The inspector notes that whilst the licensee has adequately substantiated the corrosion protection of the pH 11.4 water in the normal operating conditions; there are gaps in its evidence at high temperatures. The evidence produced demonstrates that this is fully substantiated up to 50˚C bulk pond water temperature, whereas the local conditions around the fuel are modelled to reach 62˚C. Whilst operational experience demonstrates that the likelihood of failure is low at these elevated temperatures this is not fully substantiated by technical data. The inspector recommends that further evidence is developed to underpin this aspect. I support this recommendation and have captured this in RI6733 to ensure this aspect is considered as part of the regulatory assessment of the 9MW safety case.

72. The chemistry specialist has assessed the licensee's modelling of the pond and is content that this meets RGP detailed in the SAPs. They note that the sampling regime

developed as part of the pH9 permission in 2016 (Ref 35) will remain broadly unchanged and is satisfied that this remains adequate. During the assessment an issue was raised whereby the pond water pH is being increased will result in more caustic required to be added than is necessary to maintain the pH at 11.4. This issue has was subsequently reviewed during the readiness inspection (See section 4.8) and the chemical engineering specialist is satisfied that the licensee's arrangements for commissioning the pH dosing equipment are adequate for controlling and monitoring the dosing rate and pH levels in the pond.

73. In respect of condition monitoring of the fuel and equipment stored in the pond, the inspector notes that the use of corrosion coupons is good practice and that SL has adequate arrangements in place to detect fuel failures by the pond sampling arrangements. The specialist inspector reviewed the licensee's arrangements for managing failed fuel and is content these are adequate; however some of the contingency plans require further development, specifically around hydrogen peroxide management and fuel examination capability. These are dependent on the availability of AHF where detailed fuel inspection takes place. This facility is currently scheduled to close in 2028 so there is no impact on operations for the next 10 years, however beyond this timeframe additional contingency needs to be developed. The NDA is currently working with other stakeholders (SL, EDF, the National Nuclear Laboratory, and the Ministry of Defence) in identifying the requirements and developing business case for this future facility. To address these longer term issues, the inspector makes the following recommendations:

- The Licensee should further develop its contingency measures in the case of a failed fuel event. The Licensee should also develop its safety case for the management of hydrogen peroxide in a sealed 63c rack, as part of the 9MW cooling case scheduled for 2022/23.

- The Licensee should further develop its contingency measures in post irradiation and storage examination of spent fuel in the case of the closure of the Active Handling Facility and unavailability of an equivalent facility, as part of the 9MW cooling case scheduled for 2022/23.

74. I have reviewed the licensee's current arrangements and note that it does not intend to utilise the 63c rack for several years whilst the supply chain is developed to construct them (Ref 3). The chemistry inspector notes that that hydrogen peroxide is generated as a result of radiolysis, an inherently slow process, and will only build up when the 63c rack is sealed. Considering this alongside the low likelihood of fuel failure in storage (see section 4.6), and that there are alternative options for managing failed fuels that do not require failed fuel to be sealed within the 63c rack during the first 10-15 years of storage (see section 4.8), the chemistry inspector and I are content that existing arrangements for managing hydrogen peroxide are reasonable and do not preclude safe storage of spent AGR fuel. I have captured the chemistry recommendations in RI6733 to ensure they are captured as part of future permissioning work.

75. The chemistry specialist inspector concludes that SL's safety case demonstrates that from a chemistry perspective, the risk of storage of AGR fuel in TR&S has been reduced ALARP and supports the release of the regulatory hold point to allow SL commence interim storage in TR&S up to a heat load of 1.7MW.

4.8 PROJECT INSPECTOR ASSESSMENT

76. In addition to the assessments undertaken by the specialist inspectors, I have undertaken my own review as project inspector through routine regulatory engagements, an inspection on operational records of the fuel (Ref 30), and undertaking a readiness inspection (Ref 31). This covered a wide cross-section of

systems and processes that have been modified to enable the interim storage of fuel within the TR&S pond.

77. The decision making process for interim wet storage of fuel commenced around 15 years ago and has been subject to continued regulatory oversight from the lead ONR inspector ensuring the licensee has considered RGP and followed an appropriate decision making process via the Oxide Operating Strategy Regulatory Forum and routine interventions. Therefore, as part of this permission it has not been subject to further detailed review by ONR specialist inspectors. In order to assure myself that the licensee has reached an appropriate and safe solution, I reviewed the licensee's decision making process to select wet storage (Ref 5), noting that this is a different approach to most other countries where dry cask storage is utilised for interim storage of spent nuclear fuels, although wet storage is also used by other countries for interim storage of spent fuels.

78. The licensee undertook optioneering analysis and studies reviewing all available technologies for fuel storage and the facilities and experience held by Sellafield Ltd. This review concluded that wet storage in TR&S presents the optimum solution as it is in existing facility that broadly meets modern standards, provided it is subject to continued maintenance and renewal activities, and SL has 30 years of experience in wet storage of AGR fuels. In addition, AGR reactor technology is unique to the UK and the existing dry storage casks used elsewhere would require modification to adapt to the AGR fuels and does not give any significant safety or strategic advantages over wet storage. Considering the time, technical challenges, and cost of developing the cask technology and the dry storage facility to house them, I am content that SL's decision to undertake wet storage in TR&S is a reasonable decision that reduces risks during storage to ALARP and that fuel will remain in an acceptable condition for final disposal.

79. SL is currently developing the supply chain for the 63c rack and as such will not be implementing the use of these immediately. The design and key safety features of the rack have been assessed by the Mechanical Engineering specialist inspector (see section 4.4) who is content that these meet the relevant regulatory expectations detailed in the SAPs. SL states that it can continue to safely store the fuel in the existing 20c which it has used to store fuel for several decades. The use of the 20c skip has been reviewed and assessed by ONR throughout the operation of TR&S through routine regulatory engagements and the periodic safety reviews. As use of these skips remains the same for future operations I am content this approach is justified. If there are fuel failures prior to repacking into 63c racks, I am satisfied SL has adequate arrangements to manage this (see paragraphs 79-82).

80. I undertook an intervention (Ref 32) at the manufacturing site for the 63c racks where I reviewed the process for constructing the racks and viewed the first 8 in various stages of completeness. I am content that the racks can be built to the standard required and produced at the rate necessary to support ongoing operations at the AGR stations and in spent fuel management at Sellafield. This view is supported by the Mechanical Engineering and Criticality specialist inspectors.

81. I undertook an LC25 "Operational Records" inspection (Ref 30) focussed on two key aspects: SL's records management arrangements to support long-term storage of spent AGR fuel on the site, such that should a fuel failure event occur (potentially decades away) SL has the ability to identify the origin of that fuel and identify other fuel that has a similar operational and storage history; and SL's access to the necessary records to facilitate future disposability of spent AGR fuel stored upon the site.

82. The inspection sampled two skips currently stored in the TR&S pond. The licensee was able to provide a complete operational history for the fuel from receipt on site in the late 1990's until the date of the inspection in August 2018. In addition, through

discussions with EDF, SL was able to provide assurances that it has access to the operational data from when the fuel was in the reactor. Overall, I am satisfied that SL has appropriate arrangements and adequate records to support safe storage of spent AGR fuel in the TR&S pond. The inspection demonstrated that SL has the ability to identify fuel, the operational and storage conditions throughout the entire lifetime of the fuel, down to a suitable level of detail. SL also demonstrated it has access to appropriate records to underpin safety for long-term storage and eventual disposal.

83. SL will need to continue to develop the records requirements for disposal in conjunction with EDF and Radioactive Waste Management (RWM), to enable production of a suitable record retention schedule to underpin the disposability case for disposal of AGR fuel to a future GDF. I have discussed this aspect with the THORP site inspector and the ONR Nuclear Liabilities specialist inspector responsible for this who will continue to monitor the licensee's progress with this as the GDF requirements are developed.

84. I have reviewed the licensee's plans for managing failed AGR fuel and this is broadly split into three aspects: 1. Fuel fails prior to receipt at Sellafield i.e. at AGR station, 2. Fuel fails after leaving AGR station but prior to receipt in TR&S and 3. Fuel fails during storage in TR&S. I am satisfied that these three scenarios cover all the potential possibilities where fuel could fail.

85. SL claims that if fuel fails at an AGR station, going forwards it will be bottled at the station and transferred to Sellafield. The fuel would then be processed at the Active Handling Facility (AHF) where it would be sealed into a welded can which would then be transferred to TR&S for interim storage. If AHF is unavailable the fuel can be buffer stored for longer at the AGR stations, and can be buffer stored in AGRSP as further contingency is there are sufficient strategic drivers and agreement between SL, NDA, and EDF. I am content that this approach is reasonable as the can becomes the primary containment boundary. At present failed fuel is reprocessed, so the whilst use of welded cans for interim storage is new, SL and NNL currently undertake similar canning processes as part of the repacking for post irradiation examination of spent fuels and I am content the technology, equipment, and processes are proven and available.

86. The second scenario occurred recently when some AGR fuel elements failed during dismantling at FHP which was subsequently detected during transfer to AGRSP. In this instance SL elected to reprocess the failed fuel but this will not be an option going forwards. Instead, SL has identified a number of options, either transfer to AHF for repacking into a welded can, storage in the 20c skip in AGRSP where the purge is treated, or transfer to TR&S for storage in the 63c rack either sealed or unsealed depending on the activity release rates. The transfer and storage of failed AGR in 20c skips fuel is captured within the AGRSP safety case and can be undertaken utilising the existing processes and equipment at Sellafield. I am content that this approach is reasonable and SL has a robust decision making process (Ref 5) in place to determine the appropriate action to take.

87. The third scenario is where fuel fails in situ in TR&S. In this scenario SL claims it has a number of options. If the rate of activity release is suitably small it can tolerate the failed fuel and continue to operate as planned, if the rate is higher, it can seal the fuel in the 63c Rack making this the primary containment boundary. If the fuel fails during the early part of the storage period i.e. up to around 2030, the fuel can be transferred to the AGRSP for storage which covers the gap until the 63c rack is deployed and substantiated. The ONR Structural Integrity and Chemistry specialist inspectors have identified that the safety case for sealing fuel within the rack currently requires further substantiation to provide assurances that the fuel will remain in a condition suitable for interim storage. This is not an issue for this permission as failed fuel can be safely stored in a 20c skip as detailed above. These recommendations have been captured

as part of RI6733 to be resolved prior to the release of the regulatory hold point to increase the heat limit in the pond from 1.7MW currently scheduled for 2023.

88. All the actions SL has identified have been assessed by its HF specialists and fully tested and proven in use with the exception of sealing the 63c rack. SL states that since sealing a 63c rack would be a non-routine contingency operation that may never be necessary, it has not trained its operators in this process, instead it intends to manage this through its operational and conservative decision making processes (Ref 5) and provide the necessary instructions, training and management oversight to operators just prior to sealing the rack. I am satisfied that this approach is reasonable as the failure mechanisms result in perforations and small penetrations in the fuel clad limiting the release of activity, giving SL time to fully consider its options before taking action. Overall I am content that SL has a suitable strategy and process in place for handling failed AGR fuels. This view is supported by the specialist assessments discussed earlier in this report.

89. I have reviewed the licensee's contingency strategy should through life monitoring indicate that it cannot interim store the fuel in TR&S. SL's through life monitoring regime has been reviewed by the Civil Engineering, Structural Integrity, Mechanical Engineering, and Chemistry specialist inspectors who are content that it will detect issues early. This through life monitoring capability coupled with the ability to seal fuel in the rack for up to 40 years provides sufficient time for an alternative storage process to be developed i.e. design and construct an alternative facility, to empty the pond, and transfer the fuel into the new facility. In the unlikely scenario that there is an event that results in large quantities of fuel failing during the storage period, I am satisfied that the pond should still be manageable as proven by the years of operational experience from other ponds at Sellafield and by the chloride ingress events in TR&S in 2005(Ref 37) which resulted in significant quantity of failed fuel that had to be managed until it could be reprocessed.

90. I undertook an LC22 readiness inspection (Ref 31) during in which I sampled the Licensee's arrangements for implementing the safety case and judged to be adequate the following:

- the clearance certificate,
- operational arrangements,
- pH dosing control systems,
- the 63c fuel storage rack,
- asset care and maintenance arrangements,
- the status of key safety documentation, and
- the internal control mechanisms in place to enable the safe commencement of interim fuel storage.

91. SL was able to demonstrate that it had a clear understanding of the impact of the modifications to plant, processes, and people to support the commencement of the ASTOP safety case.

92. From my discussions with the licensee and examination of the relevant safety documentation, I am content that the licensee has derived learning from plant operating experience, previous events and industrial standards. I judge the licensee's arrangements to be adequate for successful implementation of the safety case, applying relevant good practice.

5 CONCLUSIONS

93. This report presents the findings of ONR's assessment of the safety case associated with the licensee's request to store AGR fuel up to 1.7MW heat loading in the TR&S pond until final disposal in the GDF, currently scheduled for 2085.

94. I reviewed the licensee's safety case and arrangements for interim storage of AGR fuels in TR&S and judge that these are adequate and demonstrate that risks have been reduced to as low as reasonably practicable. This judgement is supported by ONR nuclear safety specialist inspectors who have assessed specific areas of the safety case.

95. Whilst all the specialist inspectors support releasing the regulatory hold point, they raised a number of recommendations relating to further work required by the licensee to enable future regulatory permissioning to increase the heat storage limit in the pond to 9MW, currently scheduled for 2023. These recommendations have been collated and captured in regulatory issue (RI6733) and a regulatory letter (Ref 36) to the licensee setting clear actions for the licensee to progress and address in its future safety case, and as conditions of future ONR permissions. ONR inspectors will continue to maintain regulatory oversight of SL's developments as part of routine business.

96. Based on ONR's readiness inspection of the plant, people, and processes associated with implementing the ASTOP safety case, I am satisfied that the licensee has adequate arrangements to commence interim storage of AGR fuels.

97. I have reviewed the licensee's failed fuel management case and I am content that this covers the full range of operations, and that SL has adequate contingency built into its arrangements should it identify a significant problem. These views are supported by the Structural Integrity and Chemistry specialist inspectors who also assessed these aspects of the licensee's safety case.

98. Overall, on the basis of ONR's assessment and inspections, I am content that the licensee's claims, arguments and evidence presented in its safety case adequately demonstrate safe interim storage of AGR fuel in the TR&S pond up to 1.7MW.

99. I consulted the Environment Agency who raised no objections to ONR agreeing to the licensee's proposal.

6 RECOMMENDATIONS

100. The project assessment report recommends that ONR issues LI516 to allow SL to commence interim storage of AGR fuels in TR&S up to a heat loading of 1.7MW.

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12. 2018/367728, 2018/367784, 2018/367730 - RP/TH-BXXX/PROJ/00188 - Design Assessment/Justification Report
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